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TITLE: Methods and apparatus for managing a flow of packets using change and reply signals

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Abstract Text - ABTX (1):
   Techniques are provided for controlling a flow of packets in a data communications device. A first technique involves transferring packets of a particular packet flow based on an initial policy scheme, and planning a scheme change to change the initial policy scheme to a **new policy** scheme based on conditions within the data communications device existing while transferring the packets of the particular flow based on the initial policy scheme. The first technique further involves providing a change signal to the source of a particular packet flow (e.g., a sending host). The change signal indicates that the data communications device has planned the scheme change. Additionally, the first technique involves processing the scheme change based on either a reply signal from, the source or an absence of a reply signal from the source.

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   19990628

Brief Summary Text - BSTX (15):
   One embodiment of the invention is directed to a technique for managing a flow of packets in a data communications device. The technique involves transferring packets of a particular packet flow based on an initial policy scheme, and planning a scheme change to change the initial policy scheme to a **new policy** scheme. Such planning is based on transfer conditions within the data communications device existing while transferring the packets of the particular flow based on the initial policy scheme. The technique further involves providing a change signal to a source of the particular packet flow (e.g., a sending host). The change signal indicates that the data communications device has planned the scheme change. Additionally, the technique involves processing the scheme change based on either a reply signal from the source or an absence of a reply signal from the source.

Brief Summary Text - BSTX (16):
   In one arrangement, the initial policy scheme is an initial packet dropping scheme for dropping packets from the particular packet flow. In this arrangement, the **new policy** scheme is a new packet dropping scheme for dropping packets from the particular packet flow in a manner that is different than that of the initial packet dropping scheme. Preferably, the initial packet dropping

scheme is not to drop any packets, and the new packet dropping scheme is to drop packets in accordance with a Random Early Detection (RED) policy (e.g., a Weighted Random Early Detection **policy or a distributed version** of a Random Early Detection policy).

Brief Summary Text - BSTX (17):
    In another arrangement, the initial policy scheme is an initial packet scheduling scheme for scheduling packets of the particular packet flow for transmission. In this arrangement, the **new policy** scheme is a new packet scheduling scheme for scheduling packets of the particular packet flow for transmission in a manner that is different than that of the initial packet scheduling scheme. Preferably, the initial packet scheduling scheme is a Weighted Fair Queuing (WFQ) policy scheme, and the **new policy** is a variation of the WFQ policy scheme.

Brief Summary Text - BSTX (18):
    In yet another arrangement, the initial policy scheme is an initial packet classification scheme for classifying packets of the particular packet flow. In this arrangement, the **new policy** scheme is a new packet classification scheme for classifying packets of the particular packet flow in a manner that is different than that of the initial packet classification scheme. Preferably, the initial packet classification scheme is a precedence-based (e.g., Quality of Service (QoS) based) policy scheme, and the new packet classification scheme is a variation of the precedence-based policy scheme.

Brief Summary Text - BSTX (20):
    If the reply signal indicates that the source accepts the scheme change, the data communications device changes the initial policy scheme to the **new policy** scheme. Accordingly, the data communications device subsequently transfers packets of the particular packet flow based on the **new policy** scheme rather than the initial policy scheme.

Brief Summary Text - BSTX (21):
    If the data communications device does not receive a reply signal from the source within a timeout period, the data communications device considers a timeout condition to have occurred. In response to the timeout condition, the data communications device changes the initial policy scheme to the **new policy** scheme such that the packets of the particular packet flow subsequently are transferred based on the **new policy** scheme rather than the initial policy scheme.

Brief Summary Text - BSTX (24):
    Another embodiment of the invention is directed to a technique for providing a flow of packets from a data source (e.g., a sending host) to a data communications device. The technique involves outputting packets of a particular packet flow to a data communications device that transfers the packets of the particular packet flow based on an initial policy scheme. Additionally, the technique involves receiving, in response to the outputted

packets of the particular packet flow, a change signal from the data communications device. The change signal indicates that the data communications device has planned a scheme change to change the initial policy scheme to a **new policy** scheme. Furthermore, the technique involves providing, to the data communications device, a reply signal that provides direction for processing the scheme change.

Brief Summary Text - BSTX (28):

Another embodiment of the invention is directed to a packet drop circuit for dropping packets stored within a data communications device. The packet drop circuit includes a monitor circuit that monitors the data communication device for a particular transfer condition while the data communications device transfers packets of a particular flow based on an initial policy scheme. Additionally, the packet drop circuit includes a change circuit, coupled to the monitor circuit, that plans a scheme change to change the initial policy scheme to a **new policy** scheme in response to a detection of the particular transfer condition by the monitor circuit. Furthermore, the packet drop circuit includes a notification circuit, coupled to the change circuit, that provides notification of the planned scheme change.

Detailed Description Text - DETX (32):

In step 154, the data communications device 40 performs the scheme change. In particular, the data communications device 40 replaces the initial policy scheme with the **new policy** scheme. For example, the data communications device 40 replaces a FIFO classification policy with a QoS classification policy to subsequently route packets based on priority rather than time of receipt.

Detailed Description Text - DETX (38):

In step 164, the source 50 receives, in response to the outputted packet flow, a change signal 36 indicating that the data communications device 40 has planned a scheme change to change the initial policy scheme to a **new policy** scheme.

Detailed Description Text - DETX (41):

In step 172, the source 50 sends, to the data communications device 40, a reply signal (e.g., see the reply signal packet 38 in FIG. 5) accepting the scheme change. In response, the data communications device 40 will perform the scheme change by replacing the initial policy scheme with a **new policy** scheme.

Detailed Description Text - DETX (47):

Suppose that the network conditions around NODE D change shortly after NODE A begins providing the video service (i.e., the packet flow 35) to the end-user at NODE G (see step 162 in FIG. 7 and step 142 in FIG. 6). In particular, suppose that packets 34 of the video service initially have a medium priority, and that the bursts of other medium priority packets from other nodes 22 begin to congest NODE D. At that point, the controller 44 of NODE D plans to switch an initial policy scheme to a **new policy** scheme which, when implemented, will affect the transfer of the video packet flow 35 (see step 144 in FIG. 6). As

one example, the controller 44 may plan to switch the FIFO classification policy to a QoS classification policy (see the new classification policy scheme 70 in FIG. 2). As another example, the controller 44 may plan to switch the WFQ scheduling policy to a DWFQ scheduling policy (see the new scheduling policy scheme 74). As yet another example, the controller 44 may plan to switch the RED drop policy to a WRED drop policy (see the new drop policy scheme 78) thus causing certain video packets 34 to be dropped.

Claims Text - CLTX (1):

1. In a data communications device, a method for managing a flow of packets, comprising the steps of: transferring packets of a particular packet flow based on an initial policy scheme; planning a scheme change to change the initial policy scheme to a **new policy** scheme based on transfer conditions within the data communications device existing while transferring the packets of the particular flow based on the initial policy scheme; providing a change signal to a source of the particular packet flow, the change signal indicating that the data communications device has planned the scheme change; and processing the scheme change based on one of (i) a reply signal from the source and (ii) an absence of the reply signal from the source.

Claims Text - CLTX (2):

2. The method of claim 1 wherein the initial policy scheme is an initial packet dropping scheme for dropping packets from the particular packet flow, and wherein the **new policy** scheme is a new packet dropping scheme for dropping packets from the particular packet flow in a manner that is different than that of the initial packet dropping scheme.

Claims Text - CLTX (3):

3. The method of claim 1 wherein the initial policy scheme is an initial packet scheduling scheme for scheduling packets of the particular packet flow for transmission, and wherein the **new policy** scheme is a new packet scheduling scheme for scheduling packets of the particular packet flow for transmission in a manner that is different than that of the initial packet scheduling scheme.

Claims Text - CLTX (4):

4. The method of claim 1 wherein the initial policy scheme is an initial packet classification scheme for classifying packets of the particular packet flow, and wherein the **new policy** scheme is a new packet classification scheme for classifying packets of the particular packet flow in a manner that is different than that of the initial packet classification scheme.

Claims Text - CLTX (9):

9. The method of claim 1 wherein the step of processing the scheme change includes the steps of: receiving, from the source, the reply signal accepting the scheme change; and changing, in response to the reply signal, the initial policy scheme to the **new policy** scheme such that packets of the particular packet flow subsequently are transferred based on the **new policy** scheme rather than the initial policy scheme.

Claims Text - CLTX (10):

10. The method of claim 1 wherein the step of processing the scheme change includes the steps of: detecting an occurrence of a timeout condition indicating that, since the change signal was provided, a timeout period has elapsed without receiving the reply signal from the source; and changing, in response to the occurrence of the timeout condition, the initial policy scheme to the **new policy** scheme such that packets of the particular packet flow subsequently are transferred based on the **new policy** scheme rather than the initial policy scheme.

Claims Text - CLTX (11):

11. A data communications device for managing a flow of packets, comprising: a transfer circuit that transfers packets of a particular packet flow based on an initial policy scheme; a controller, coupled to the transfer circuit, that plans a scheme change to change the initial policy scheme to a **new policy** scheme in response to a particular transfer condition within the data communications device existing while the transfer circuit transfers the packets of the particular flow based on the initial policy scheme; and a feedback circuit, coupled to the controller, that provides a change signal to a source of the particular packet flow, the change signal indicating that the data communications device has planned the scheme change, the feedback circuit enabling the controller to process the scheme change based on one of (i) a reply signal from the source and (ii) an absence of the reply signal from the source.

Claims Text - CLTX (12):

12. The data communications device of claim 11 wherein the initial policy scheme is an initial packet dropping scheme for dropping packets from the particular packet flow, and wherein the **new policy** scheme is a new packet dropping scheme for dropping packets from the particular packet flow in a manner that is different than that of the initial packet dropping scheme.

Claims Text - CLTX (13):

13. The data communications device of claim 11 wherein the initial policy scheme is an initial packet scheduling scheme for scheduling packets of the particular packet flow for transmission, and wherein the **new policy** scheme is a new packet scheduling scheme for scheduling packets of the particular packet flow for transmission in a manner that is different than that of the initial packet scheduling scheme.

Claims Text - CLTX (14):

14. The data communications device of claim 11 wherein the initial policy scheme is an initial packet classification scheme for classifying packets of the particular packet flow, and wherein the **new policy** scheme is a new packet classification scheme for classifying packets of the particular packet flow in a manner that is different than that of the initial packet classification scheme.

Claims Text - CLTX (19):
  19. The data communications device of claim 11 wherein the feedback circuit is configured to: (i) receive, from the source, the reply signal accepting the scheme change; and (ii) instruct the controller to change, in response to the reply signal, the initial policy scheme to the **new policy** scheme such that the transfer circuit transfers packets of the particular packet flow based on the **new policy** scheme rather than the initial policy scheme.

Claims Text - CLTX (20):
  20. The data communications device of claim 11 wherein the feedback circuit is configured to: (i) detect an occurrence of a timeout condition indicating that, since the change signal was provided, a timeout period has elapsed without receiving the reply signal from the source; and (ii) instruct the controller to change, in response to the occurrence of the timeout condition, the initial policy scheme to the **new policy** scheme such that packets of the particular packet flow subsequently are transferred based on the **new policy** scheme rather than the initial policy scheme.

Claims Text - CLTX (21):
  21. A method for providing a flow of packets, comprising the steps of: outputting packets of a particular packet flow to a data communications device that transfers the packets of the particular packet flow based on an initial policy scheme; receiving, in response to the outputted packets of the particular packet flow, a change signal from the data communications device, the change signal indicating that the data communications device has planned a scheme change to change the initial policy scheme to a **new policy** scheme; and providing, to the data communications device, a reply signal that provides direction for processing the scheme change.

Claims Text - CLTX (26):
  26. An apparatus for providing a flow of packets, comprising: a transfer circuit that outputs packets of a particular packet flow to a data communications device that transfers the packets of the particular packet flow based on a policy scheme; and a controller, coupled to the transfer circuit, that (i) receives, in response to the outputted packets of the particular packet flow, a change signal from the data communications device, the change signal indicating that the data communications device has planned a scheme change to change the policy scheme from an initial policy scheme to a **new policy** scheme, and (ii) provides, to the data communications device, a reply signal that provides direction for processing the scheme change.

Claims Text - CLTX (31):
  31. A computer program product that includes a computer readable medium having instructions stored thereon for managing a flow of packets in a data communications device, such that the instructions, when processed by the data communications device, cause the data communications device to perform the steps of: transferring packets of a particular packet flow based on an initial

policy scheme; planning a scheme change to change the initial policy scheme to a **new policy** scheme based on transfer conditions within the data communications device existing while transferring the packets of the particular flow based on the initial policy scheme; providing a change signal to a source of the particular packet flow, the change signal indicating that the data communications device has planned the scheme change; and processing the scheme change based on one of (i) a reply signal from the source and (ii) an absence of the reply signal from the source.

Claims Text - CLTX (32):

32. A computer program product that includes a computer readable medium having instructions stored thereon for providing a flow of packets from a computerized apparatus, such that the instructions, when processed by the computerized apparatus, cause the computerized apparatus to perform the steps of: outputting packets of a particular packet flow to a data communications device that transfers the packets of the particular packet flow based on an initial policy scheme; receiving, in response to the outputted packets of the particular packet flow, a change signal from the data communications device, the change signal indicating that the data communications device has planned a scheme change to change the initial policy scheme to a **new policy** scheme; and providing, to the data communications device, a reply signal that provides direction for processing the scheme change.

Claims Text - CLTX (33):

33. The method of claim 1 wherein the step of processing includes the step of: accepting the reply signal from the source; changing the initial policy scheme to the **new policy** scheme when contents within a reply field of the reply signal represent a first value; and maintaining the initial policy scheme when the contents within the reply field of the reply signal represent a second value that is different than the first value.

Claims Text - CLTX (35):

35. The method of claim 21 wherein the step of providing includes the step of: selectively including one of (i) a first value in a reply field of the reply signal to change the initial policy scheme to the **new policy** scheme, and (ii) a second value in the reply field of the reply signal to maintain the initial policy scheme, the first value being different than the second value.